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# Implementation Monitoring Forestry Best Management Practices for Site Preparation in South Carolina 1996





### **ACKNOWLEDGMENTS**

Funding for this project was provided by the South Carolina Forestry Commission and the U.S. Environmental Protection Agency through a federal grant under Section 319 of the Clean Water Act.

**Implementation Monitoring  
of Forestry  
Best Management Practices  
for  
Site Preparation in South Carolina**

**1996**

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**Best Management Practices Monitoring Report BMP-3**

Published by the South Carolina Forestry Commission

Columbia, South Carolina

December, 1996

# Introduction

In South Carolina, silvicultural guidelines were first published in 1976 by the South Carolina Forestry Association. *Best Management Practices for South Carolina's Forest Wetlands* was published by the South Carolina Forestry Commission (SCFC) in 1989. Silvicultural guidelines were updated in 1994 when the SCFC published *South Carolina's Best Management Practices for Forestry* to replace the two earlier manuals.

Compliance with Best Management Practices (BMPs) for harvested sites has been surveyed three times in South Carolina. Overall BMP compliance was 84.5% in the baseline survey in 1990<sup>1</sup>, 84.7% in 1991<sup>2</sup>, and 89.5% in 1994<sup>3</sup>. Until this project, no survey has documented BMP compliance for site preparation activities. This baseline study was designed to determine the level of compliance with site preparation BMPs in South Carolina.

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<sup>1</sup>. Hook, D.D., W. McKee, T. Williams, B. Baker, L. Lundquist, R. Martin, and J. Mills. 1991. *A Survey of Voluntary Compliance of Forestry Best Management Practices*. South Carolina Forestry Commission. Columbia, South Carolina.

<sup>2</sup>. Adams, T. and D. Hook. 1993. *Implementation and Effectiveness Monitoring of Forestry Best Management Practices on Harvested Sites in South Carolina*. South Carolina Forestry Commission. Columbia, South Carolina.

<sup>3</sup>. Adams, T. 1994. *Implementation Monitoring of Forestry Best Management Practices on Harvested Sites in South Carolina*. South Carolina Forestry Commission. Columbia, South Carolina.



# Study Methods

## Site Location

One hundred seventy-seven sites were located in South Carolina for evaluation of compliance with site preparation BMPs. The number of sites selected was based on the sample size needed for statistical analysis. BMP compliance checks were completed on property that was site-prepared within one year prior to the on-site evaluation. Most of the tracts were site-prepared between June, 1995 and December, 1995, and they were inspected during the spring of 1996. Also, site-prepared tracts had to be a minimum of 10 acres. Sites were not required to be associated with streams or wetland areas as was the case in earlier rounds of monitoring.

Selected sites were distributed in proportion to the volume of timber harvested in all counties. The average volume of timber harvested in individual counties was based on unpublished annual timber harvest data collected by the U. S. Forest Service. The number of sites sampled within any particular county was in proportion to the percent of that county's harvest in relation to the entire state. Statewide, the number of sites located within individual counties ranged from one to seven sites. Sites were identified by SCFC foresters from fixed-wing aircraft.

## Landowner Questionnaire

SCFC foresters contacted all landowners whose sites were selected for BMP compliance checks. Four categories of landowners were recognized for the purpose of this study: (1) non-industrial private landowners who own less than 1,000 acres of forestland, (2) non-industrial private landowners who own more than 1,000 acres of forestland, (3) public lands (both state and federal), and (4) industrial lands. Prior to site inspection, landowners were questioned concerning their familiarity with BMPs, their use of a professional forester, their use of a written site preparation contract, whether compliance with BMPs had been required of the site preparation contractor, and whether government cost-share assistance subsidized site preparation expenses.

## **BMP Compliance Inspection**

Site inspections were made during the spring of 1996. The evaluations were made by a two-person team of SCFC foresters consisting of the forest hydrologist and the project forester. The inspection covered compliance with BMPs in each of four categories of site preparation: (1) mechanical treatments, (2) herbicide applications, (3) prescribed burning, and (4) minor drainage. Each major category was evaluated on a pass/fail basis depending on the responses to a series of yes/no questions within each category.

Each site preparation operation was rated for overall BMP compliance after all individual BMPs were fully evaluated. Sites were categorized as either excellent, adequate, or inadequate depending on the level of BMP compliance. The overall compliance rating, though subjective, was based on compliance with specific BMPs as noted throughout the evaluation. When sites were rated as inadequate, the major problems on that site were identified. Sites were rated as inadequate when non-compliance with recommended water quality related BMPs resulted in an evident off-site water quality impact.

## **Statistical Analysis**

Compliance values were computed for each of the four categories of site preparation as well as for overall BMP implementation. A 95% confidence interval was calculated for each compliance value. Problems which contributed to non-compliance were identified for each of the major BMP categories and overall BMP implementation.

Eleven variables, categorized as either site characteristics or management decisions, were identified which possibly could have affected the level of BMP compliance. All of these variables were evaluated through landowner interviews or by on-site inspection of the site preparation operation. Statistical analysis was performed on each of these variables to determine the significance of their relationship with BMP compliance.



# Monitoring Results

Sites were located from fixed-wing aircraft between November 13, 1995 and January 23, 1996. Landowners were identified, contacted, and interviewed in order to complete the landowner questionnaire. BMP compliance checks were completed on 177 site-prepared tracts between February 9, 1996 and May 30, 1996. BMP compliance for each of the four major categories of site preparation and overall BMP compliance is summarized as follows.

## *Location Map for Monitored Sites*



**Figure 1**

*One hundred seventy-seven sites were evaluated for BMP compliance.*



Statewide compliance with mechanical site preparation BMPs was **92%.**

#### Picture 1

*The shear-rake-disk mechanical treatment on this Lancaster County site with 18% slopes resulted in no off-site water quality impacts due to adequate compliance with BMPs.*

*Windrows were constructed on the contour, and gullies were protected by not harvesting within them and limiting soil disturbance around the gullies during site preparation.*

## Mechanical Site Preparation

Statewide compliance with mechanical site preparation BMPs was 92.0%. Of the 112 sites which received mechanical treatments, 103 sites had acceptable compliance with BMPs, and 9 sites were rated as inadequate. Sites received acceptable ratings if the mechanical site preparation treatments were conducted in a manner sufficient to protect water quality.

Mechanical site preparation was the treatment of choice on 112 of 177 sites (63.3%) representing 9,301 acres. The preference for mechanical site preparation ranged from 86.4% in the Atlantic Coastal Plain to 46.8% in the Southern Piedmont. An increase in average site slope, from 1.6% in the Atlantic Coastal Plain to 14.2% in the Southern Piedmont, corresponded to a decrease in BMP compliance, 98.0% and 75.9%, respectively.

Mechanical treatments were preferred by all categories of forest landowners. All public lands were mechanically treated, as were 70.9% of industrial lands and 68% of large non-industrial private lands. Small non-industrial private landowners used mechanical site preparation on 53.4% of the sites.

Compliance with mechanical site preparation BMPs was comparable for all landowners, ranging from 100% for public lands to 87.2% for small non-industrial private lands.

Shear-rake-bed and shear-chop-bed treatments were the most common methods of site preparation in the coastal regions of the state, accounting for 41 of 69 sites (59.4%). In the Carolina Sandhills, Southern Piedmont, and Blue Ridge Mountain regions, shear-rake-disk and chopping were the preferred mechanical treatments on 24 of 43 sites (55.8%). Twenty-three different site preparation treatments were used statewide by







**Picture 2**

*The shear-rake-disk mechanical treatment on this Fairfield County site resulted in significant sedimentation downstream due to inadequate compliance with BMPs. Windrow construction and disking were performed up and down 28% slopes on this site. Also, the secondary streamside management zones and ephemeral drains were disked.*

forest land managers to match regeneration needs to specific site conditions.

Several BMPs apply specifically to the protection and stabilization of gullies. Gullies were protected during site preparation treatments on 11 of 15 sites which had stabilized gullies present. Gullies were protected on all three sites which had actively eroding gullies.

Bed height and bed orientation were also investigated. Fifty sites were bedded with bed heights ranging from 6" to 17" above the natural forest floor. On 29 of 33 sites that were in jurisdictional wetlands, the beds were not connected to ditches, therefore eliminating the concern of wetland drainage.

Inadequate ratings were generally due to the use of intensive mechanical treatments on steep erodible land. Eight of the nine sites with inadequate ratings received intensive mechanical treatments on strongly sloping land (16%-31% slopes) in the Southern Piedmont and Carolina Sandhills. Five sites received shear-rake-disk treatments and three sites received single-pass treatments, such as disking or straight-blade pushing. One site, a shear-rake-bed treatment in a coastal hardwood floodplain, received an inadequate rating in the Atlantic Coastal Plain.

The most common BMP violation which contributed to inadequate ratings was the lack of natural filter strips left on the contour on 11%-20% slopes. The secondary streamside management zone (SMZ) on five sites was intensively site-prepared as was the primary SMZ on three sites. The treatment of ephemeral areas also contributed to inadequate ratings with the ephemeral areas on four sites being disked and woody debris being pushed into the ephemeral areas on two sites.



Compliance with prescribed burning BMPs was **70.4%** in this survey

## Prescribed Burning

Compliance with prescribed burning BMPs was 70.4% in this survey. A total of 44 sites had prescribed fire as part of the site preparation treatment. Thirty-one sites had acceptable compliance with BMPs, and 13 sites were rated as inadequate. Sites received an inadequate rating if non-compliance with prescribed burning BMPs resulted in a likely off-site water quality impact.

The use of prescribed burning for site preparation was not as common as other site preparation treatments. Statewide, fire was used on one out of every four sites in this survey. The use of fire was lowest in coastal regions (16.5%) and highest in the Southern Piedmont (40.3%). Compliance with prescribed burning BMPs was perfect in all regions of the state except for the Southern Piedmont where only 12 out of 25 sites (48.0%) were acceptable.

The use of prescribed burning varied among the various landowner categories. Industrial forest landowners used prescribed burning for site preparation on one-third of all industrial sites in this survey. Non-industrial private forest landowners used prescribed burning on 23% of the survey sites. Prescribed burning was not used on any public lands included in this survey. Compliance with prescribed burning BMPs varied little among the landowner categories, ranging from 66.7% for industrial landowners to 75.0% for large, non-industrial private landowners.

Prescribed burning was most often used in conjunction with herbicide applications. A herbicide + burn treatment was used on 37 of the 44 sites (84.1%) in this survey. Prescribed burning in combination

### Picture 3

*Prescribed burning followed an aerial application of herbicide on this Fairfield County site. Firelines were plowed around the head of stabilized gullies to prevent reactivating them. Prevalent gullies and 22% slopes precluded the use of mechanical site preparation on this site.*







with mechanical treatments was used on four sites. A combination of all three treatments (mechanical + herbicide + burn) was used on two sites. Prescribed burning was used alone on only one site.

The herbicide + burn treatment in the Southern Piedmont was used on all 13 sites which received inadequate ratings. The average site slope for the 13 inadequate sites was 15.8% as compared to 10.2% slopes on acceptable sites. Foresters or other qualified professionals conducted the prescribed burning on all inadequate sites. Most sites were burned when moisture levels of the forest floor were adequate to prevent the entire humus layer from being consumed.

The most common BMP violations on inadequate sites involved the construction and stabilization of firelines that were plowed around the sites. On ten sites, firelines were plowed across perennial, intermittent, or ephemeral streams as opposed to tying them into stream channels with hand tools. Also, firelines were not adequately water-barred on ten of the 13 inadequate sites. Taken together, non-compliance with these two BMPs allowed eroded sediment to be introduced into active stream channels. The third most common problem on inadequate sites was the construction of firelines within primary and secondary SMZs. Other minor problems which contributed to inadequate ratings included the improper construction of water bars, and allowing high intensity fire to burn on eroded land and within SMZs.

#### Picture 4

*An aerial herbicide application followed by a prescribed burn was an appropriate site preparation prescription on this Newberry County site. However, improper fireline construction and stabilization resulted in a likely off-site water quality impact. The lack of water bars on 16% slopes allowed runoff to be channeled to the point where the fireline had been improperly tied into the stream.*



Of the 77 sites, herbicides were applied in compliance with BMPs on 68 sites for an **88.3%** BMP compliance rate.

## Herbicide Application

Herbicides were applied as site preparation on 77 study sites in this survey, representing 7,244 acres. Of the 77 sites, herbicides were applied in compliance with BMPs on 68 sites for an 88.3% BMP compliance rate. Nine sites received inadequate ratings due to likely off-site water quality impacts which resulted from the herbicide application.

Herbicides were used as a common site preparation treatment throughout South Carolina, accounting for 43% of all study sites. The preference for herbicide application ranged from 30.5% in the Atlantic Coastal Plain to 53.2% in the Southern Piedmont. BMP compliance was 100.0% in each region of the state except for the Southern Piedmont and Atlantic Coastal Plain where compliance with herbicide BMPs was 75.8% and 94.4%, respectively.

Herbicides were used by all landowner categories except for public land managers. Herbicides were applied to 48.9% of small non-industrial private lands, 47.3% of industrial lands, and 32.0% of large non-industrial private lands. BMP compliance for herbicide application was 96.2% for industry, 87.5% for large non-industrial private landowners, and 83.7% for small non-industrial private landowners.

### Picture 5

*An aerial application of herbicide was the preferred site preparation treatment on this rugged Pickens County site. Excellent implementation of BMPs protected the water quality of Lake Keowee that adjoins the site. Herbicide was not applied within the 40-foot-wide streamside management zone, and protective lines that were pushed around the site were stabilized with water bars.*







A combination of herbicide application + prescribed burning was used on 37 of the 77 chemically-treated study sites. Herbicide application was the only treatment on 26 study sites. A mechanical + herbicide application was used on 12 sites, and a mechanical + herbicide + prescribed burning treatment was used on two sites.

BMP compliance was 100% for the mechanical + herbicide and for the mechanical + herbicide + prescribed burning treatments. BMP compliance was 86.5% for the herbicide + prescribed fire treatment and 84.6% for the herbicide treatment alone. Sites with herbicide treatments which involved some mechanical work averaged 9.6% slopes versus 16.1% slopes for sites with non-mechanical treatment combinations.

Eight of the nine inadequate study sites had herbicide application plans in place and records kept of pertinent information such as application rates, wind directions and speeds, and time of application. Herbicide application was applied aerially on all nine sites. Of the nine inadequate sites, five were supervised by private consultants, three by industry foresters, and one by the herbicide applicator. Herbicide tank mixing was performed away from low-lying areas on all nine sites and no spills occurred. Also, herbicide containers were properly disposed of on all nine sites.

The most common violation of BMPs on the nine inadequate sites involved the application of herbicides in proximity to streams. On eight of the nine inadequate sites, herbicides were applied aerially over streams with flowing surface water. On seven of those sites, the herbicide killed the standing timber that had been left in the SMZ from the harvesting operation as well as any regeneration. Minor problems associated with herbicide applications on the nine inadequate sites were the lack of stabilization on push lines around the treatment area, the location of push lines within the SMZs, and the construction of push lines across streams.

### Picture 6

*This McCormick County site received an inadequate rating due to poor compliance with BMPs. Prior to site preparation, the streamside management zone (SMZ) had been improperly harvested. During site preparation, the natural regeneration within the SMZ was sprayed and herbicide was applied directly to the flowing stream. Also, herbicide control lines were constructed within the SMZ.*





**Picture 7**

*Beds were bladed down following topographic lows on this Colleton County flatwood site allowing for natural water movement between isolated gum ponds. With this technique, water flow between gum ponds was not altered, either by beds which could impede flows or by ditches which could change the hydrology of the ponds.*

## Minor Drainage

Drainage activities occurred on 13 of the 177 sites (7.3%) evaluated in this study. Ten of these 13 sites (76.9%) were ditched in accordance with BMP guidelines. Ditching activities on three sites did not comply with BMPs and these sites likely would not qualify for the silvicultural exemption under Section 404 of the Clean Water Act. In this study, ditching was rated acceptable when it was used only to remove excess surface water in order to minimize harvesting impacts or to facilitate regeneration of desired wetland species.

All 13 ditched sites were located in the Atlantic and Southern Coastal Plain regions. Eight of the ditched sites were industrial lands with the remaining five sites being non-industrial private forest lands. Jurisdictional wetlands, as delineated by the 1987 *Corps of Engineers Wetland Delineation Manual*<sup>4</sup>, were present on all 13 sites.

**Drainage activities occurred on 13 of the 177 sites (7.3%) evaluated in this study. Ten of these 13 sites (76.9%) were ditched in accordance with BMP guidelines.**

The primary terrain type on ditched sites was pine flatwoods with isolated gum ponds. Ditching involved a Carolina Bay on one site and a floodplain on another site. Prescription drainage was used on 12 sites, utilizing topographic relief to remove excess surface water. Patterned drainage, utilizing a grid system of ditches, was used on one site. Ditches were under two feet deep on three sites, two to four feet deep on five sites, and over four feet deep on five sites.

Specific drainage BMPs were evaluated on each site. Ditch construction and maintenance issues, such as placement of spoil and stabilization of the ditch, had high compliance in this study. For instance, 12 of the 13

<sup>4</sup>. Environmental Laboratory. 1987. *Corps of Engineer Wetland Delineation Manual*, Technical Report Y-87-1, US Army Engineer Waterways Experiment Station, Vicksburg, MS.





**Picture 8**

*Ditching on this site exceeded minor drainage BMPs. Ditches, ranging from two to six feet deep, were constructed through isolated gum ponds like the one in the background. With the gum ponds being neither harvested nor site prepared for planting, the ditching within the gum ponds did not meet the purpose of minor drainage, that of removing excess surface water in order to minimize harvesting impacts or to facilitate regeneration of desired wetland species.*

ditched sites had spoil placed in a manner so as not to impede the flow of surface water into the ditch. Ditch side slopes were all adequate to minimize maintenance due to erosion and sedimentation.

BMPs recommend that ditches be emptied into areas where the runoff will be diffused and filtered by the forest floor before reaching a natural channel. This was the case on six sites. On five sites, ditches were connected to existing ditches, and on two sites, ditches were connected directly to active streams.

Ditching, on the three sites which did not comply with BMPs, appeared to significantly alter the hydrology of each site. Two of these sites were industrial tracts, averaging 282 acres in size. These ditching systems were designed by the landowners to remove excess surface water from the flatwood pine sites to facilitate regeneration. However, two to six foot deep ditches were constructed, connecting isolated cypress/tupelo gum ponds to existing ditches. In not selecting a more environmentally sensitive ditching alternative, these ditches likely altered the hydrology of the gum ponds, as well as the plant and wildlife communities that had adapted to them. The third inadequate site involved ditch construction by a non-industrial private forest landowner in a coastal black-river floodplain. Two perennial streams, which crossed this hardwood site, were dredged and channelized after mechanical site preparation activities were completed in an effort to establish a loblolly pine stand.

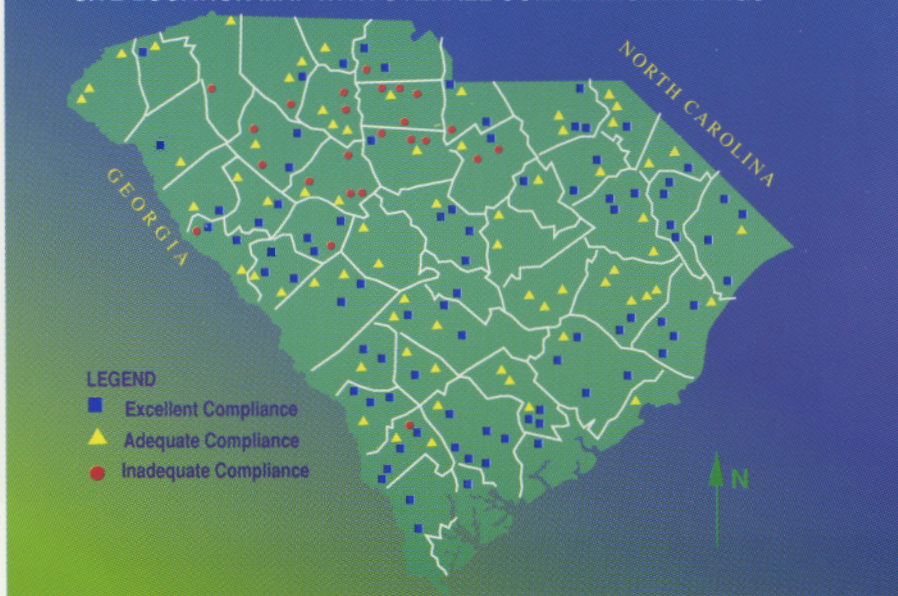


**Picture 9**

*The landowner of this Bamberg County site did not exceed minor drainage BMPs through thoughtful design of the drainage system. Ditch depths ranged from two feet in wetland areas to four feet in uplands. Short secondary ditches extended to the lip of isolated gum ponds, removing excess surface runoff when the concave ponds overflowed into surrounding pine stands.*



## SITE LOCATION MAP WITH OVERALL COMPLIANCE RATINGS



**Figure 2**

Of the 177 sites inspected, 85 sites rated excellent, 68 sites rated adequate, and 24 sites rated inadequate.

## Overall BMP Compliance

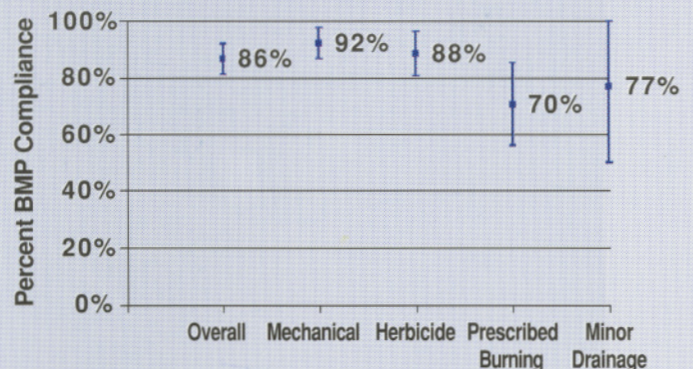
Overall compliance for site preparation BMPs in South Carolina was 86.4%. Of the 177 sites inspected, 85 sites rated excellent, 68 sites rated adequate, and 24 sites rated inadequate. Sites were given inadequate ratings if the site preparation activities resulted in a likely off-site water quality impact.

**Overall compliance for site preparation BMPs in South Carolina was 86.4%. Of the 177 sites inspected, 85 sites rated excellent, 68 sites rated adequate, and 24 sites rated inadequate.**

Overall BMP compliance was high in all regions of the state except for the Southern Piedmont where compliance was 64.5%. Only two inadequate sites were located outside of the Southern Piedmont. BMP compliance did not vary significantly among the different landowner categories.

The major problems that were identified on inadequate sites are listed on page 15.

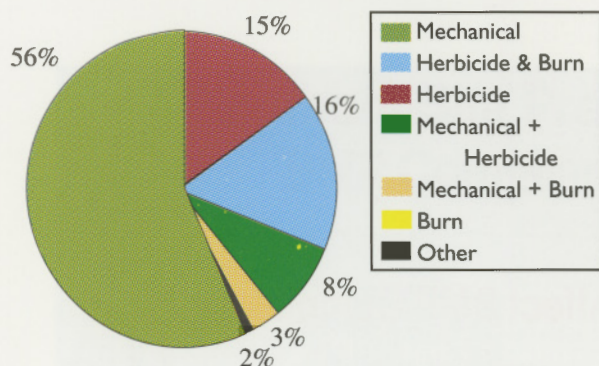
## Percent BMP Compliance with 95% Confidence Intervals



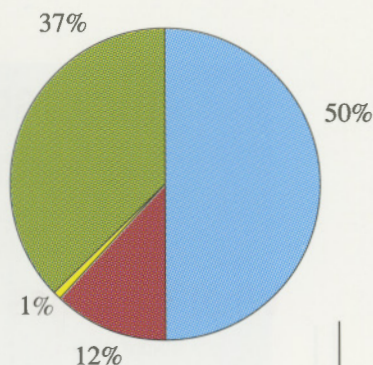


# Site Preparation Treatments on:

## Excellent and Adequate Sites



## Inadequate Sites



Mechanical, herbicide, and prescribed burning treatments were used individually and in combination over the 177 sites. Sites with excellent and adequate overall BMP compliance involved mechanical site preparation treatments 56% of the time with the second most common treatment being herbicide + burn applications on 16% of the sites. Sites with inadequate overall BMP compliance involved herbicide + burn treatments 50% of the time with mechanical treatments being utilized on 37% of the sites.

## Major Problems Identified on Inadequate Sites

Identified Problem	Number of Comments
1. Firelines not adequately water-barred	9
2. Firelines plowed across streams	8
3. SMZ sprayed with herbicide	7
4. No natural strips left on contour where needed	6
5. Firelines constructed within SMZ	6
6. Intensive mechanical treatments on 20% slopes	5
7. Herbicide applied to surface water	5
8. Intensive mechanical treatments in secondary SMZ	5
9. Intensive mechanical treatments in ephemeral areas	4
10. Intensive mechanical treatments in primary SMZ	3
11. Herbicide push lines in secondary SMZ	2
12. Herbicide push lines not stabilized	2
13. Intensive mechanical treatments not on contour	2
14. Woody debris pushed into ephemeral areas	2
15. Windrows blocking drainages	2
16. Perennial stream channelized	1
17. Prescribed burn was too hot on eroded site.	1
18. SMZ was burned	1
19. Beds were connected to perennial stream	1



## What Variables Affect BMP Compliance?

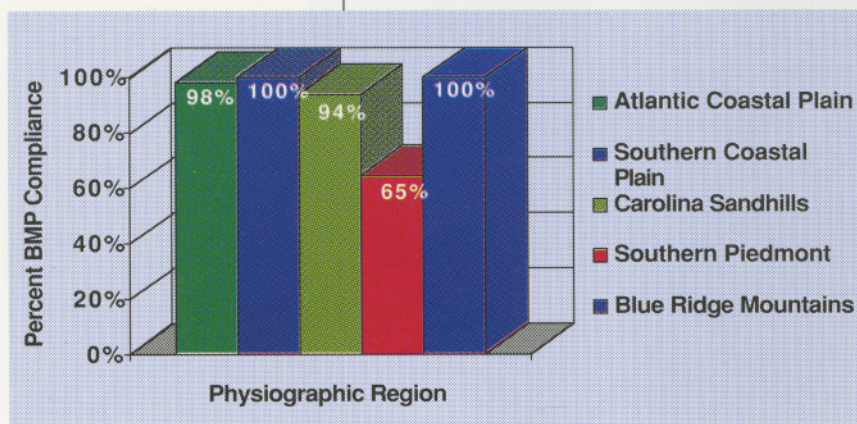
Eleven variables were analyzed to determine their effect on BMP compliance.

- ◆ Physiographic region
- ◆ Proximity to streams
- ◆ Percent slope
- ◆ Terrain type
- ◆ Landowner category
- ◆ Cost share
- ◆ Familiarity of landowner with BMPs
- ◆ Use of a site preparation contract
- ◆ Required compliance with BMPs
- ◆ Use of a professional forester
- ◆ Site preparation treatment size

Four of these 11 variables were found to be significantly related to BMP compliance. All four significant variables are interrelated site characteristics: physiographic region, proximity to streams, percent slope, and terrain type. No variable reflecting management decisions was shown to have a significant effect on BMP compliance. Each of the 11 variables is discussed in the following pages.

### Physiographic Region

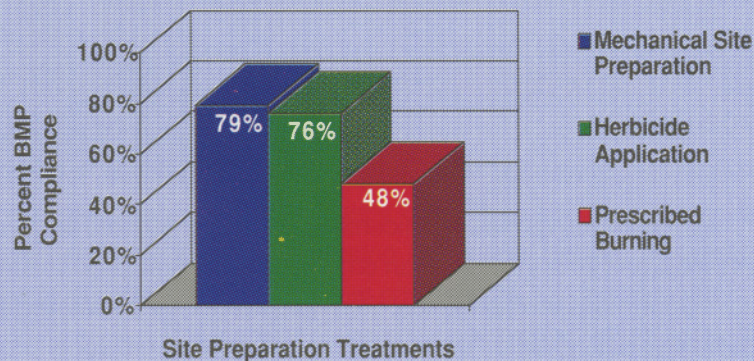
BMP compliance was significantly lower for sites in the Southern Piedmont than for sites in other physiographic regions of the state. BMP compliance was 64.5% in the Southern Piedmont versus 98.3% for the rest of the state. Of the 24 inadequate sites, 22 sites were located in the Southern Piedmont with one site each in the Atlantic Coastal Plain and Carolina Sandhills regions.



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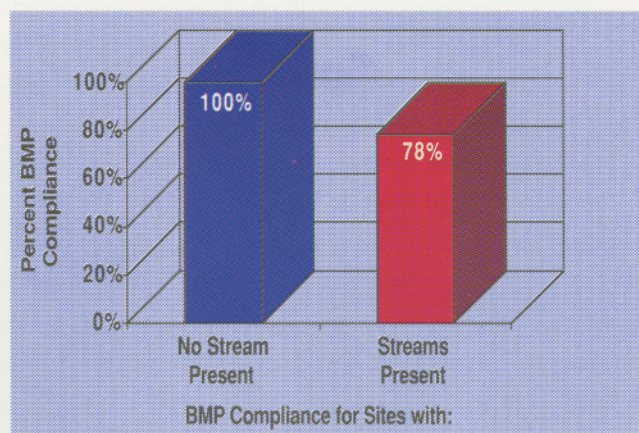
## Piedmont Site Preparation BMP Compliance



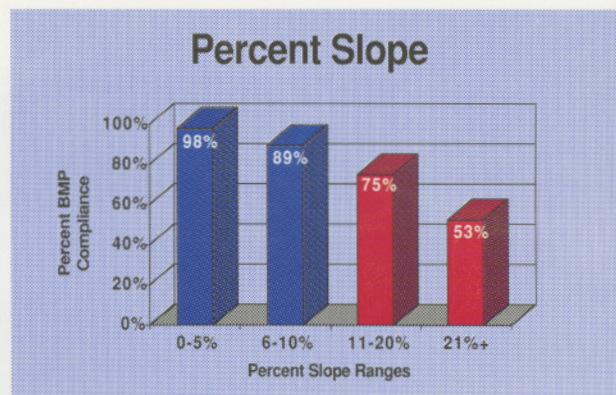
BMP compliance in the Piedmont was lowest for prescribed burning operations, due mainly to fireline construction and stabilization problems. Compliance with mechanical site preparation and herbicide application BMPs in the Piedmont was comparable. No minor drainage operation was surveyed outside of the Coastal Plain.

## Proximity to Streams

BMP compliance was significantly higher for sites that had no natural drainage features present. Where perennial, intermittent, or ephemeral streams were present, BMP compliance was 78.4%. Sites with perennial streams accounted for 21 of the 24 inadequate sites. Sites with either perennial, intermittent, or ephemeral streams accounted for all 24 inadequate sites.

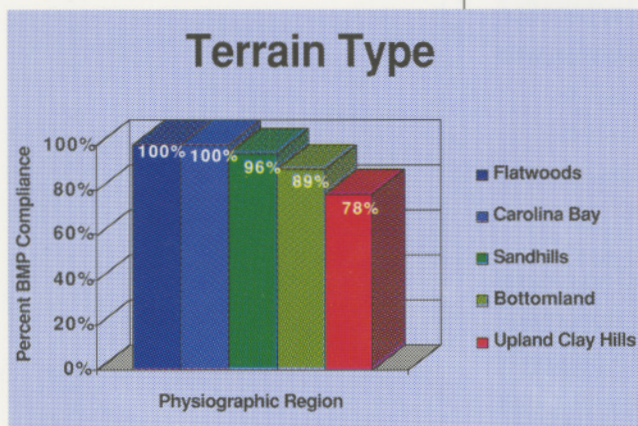






## Percent Slope

BMP compliance was significantly lower on the 59 sites with slopes in the 11-20% and 21%+ ranges than on sites with 0-5% slopes. The inappropriate use of intensive mechanical treatments on 21%+ slopes and the lack of untreated natural strips on 11-20% slopes created erosional problems. The alternative of applying herbicides was more appropriate on steep slopes as long as BMPs were followed in constructing control lines and firelines.

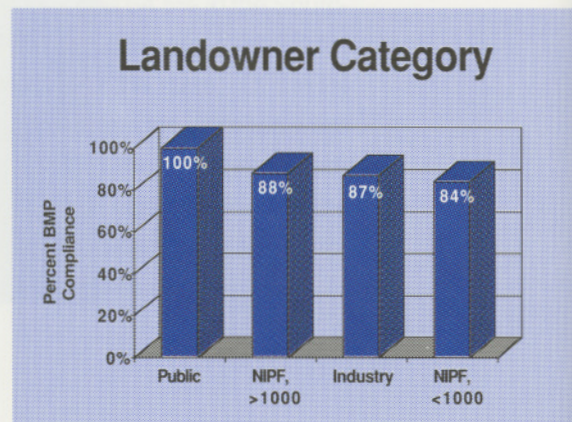


## Terrain Type

BMP compliance was significantly higher for sandhill, flatwood and Carolina bay sites than for upland clay-hill sites. Compliance on bottomland sites did not differ significantly from the other terrain types. These terrain types do not equate to physiographic regions, although they are related. For example, bottomland sites exist across all physiographic regions.

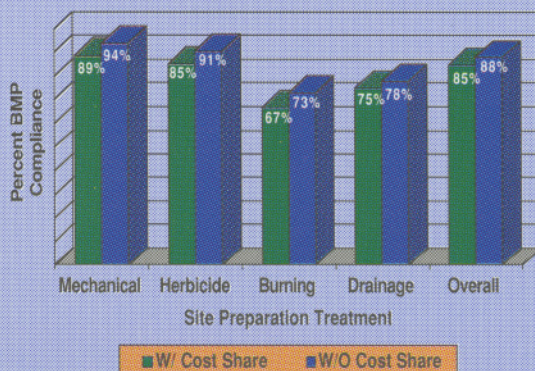
## Landowner Category

Although varying slightly, BMP compliance did not differ significantly among the four landowner categories. Compliance was perfect on the nine public sites in this survey. Large non-industrial private landowners ranked second with 88% of their 25 sites in compliance. Of the 55 industrial sites, 48 sites (87%) were in compliance with BMPs. Finally, small non-industrial private landowners ranked last with 74 of 88 sites (84%) being in compliance with BMPs.





## Cost Share



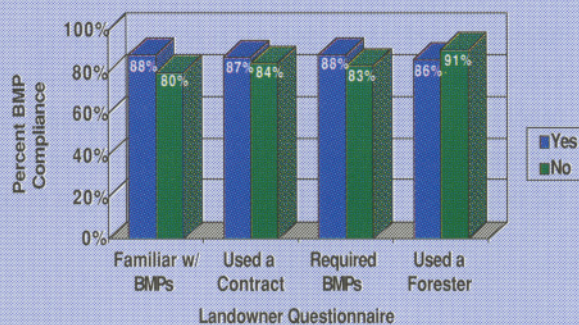
## Cost Share

Although not statistically significant, BMP compliance for sites with cost-share assistance was consistently lower than sites with no government assistance for all site preparation treatments and for overall BMP compliance. Of the 113 non-industrial private sites, site preparation treatments on 78 sites (69%) were partially funded with government cost-share payments. Of these 78 sites, 66 sites were in compliance with BMPs and 12 sites were rated inadequate. BMP compliance for sites with cost-share payments was 84.6% versus 87.9% compliance for all sites without government assistance. BMP compliance was 85.7% for all non-industrial private sites without government assistance.

## Landowner Questionnaire

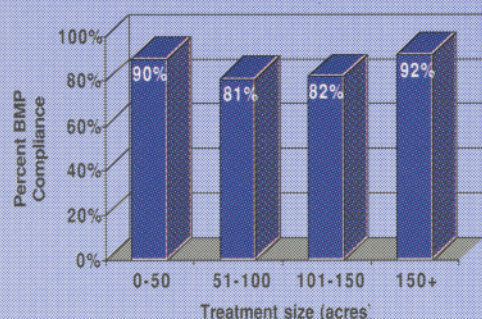
BMP compliance was not significantly affected by a landowner's familiarity with BMPs, the use of a site preparation contract, a written requirement for the use of BMPs, or the use of a forester in the prescription and supervision of site preparation. Other results of the landowner questionnaire are summarized below.

- ◆ 77% of all landowners were familiar with BMPs.
- ◆ 71% of the landowners had written contracts covering their site preparation.
- ◆ 63% of the contracts included requirements to follow BMPs.
- ◆ 94% of landowners used foresters to prescribe and supervise site preparation.





## Site Preparation Treatment Size



## Site Preparation Treatment Size

The size of the area being site-prepared for reforestation did not affect BMP compliance. Of the 177 sites, 83 sites were under 50 acres, 59 sites were between 51 and 100 acres, 22 sites were between 101 and 150 acres, and 13 sites were over 150 acres in size. The largest sampled site was 1,301 acres. A total of 14,181 acres were site-prepared for reforestation on sampled sites. Of this acreage, 51% was completed by industry, 46% was completed by non-industrial private landowners, and 3% was completed by public land managers. The average tract being site-prepared was 80.1 acres, but ranged from 132.2 acres for industry to 44.1 acres for public lands. The average size non-industrial private tract was 57.6 acres.

Four of the 11 variables that have been discussed in detail significantly affected BMP compliance in this study. Nonsignificant variables, such as landowner category or the use of a contract, may have affected BMP compliance although not at a 95% level of confidence. The four significant site characteristic variables - physiographic region, proximity to streams, percent slope, and terrain type - each describe the increased risk involved from site-preparing land that is in close proximity to streams. The density of drainage systems increases with slope, making it more likely for a typical site preparation operation in the Southern Piedmont to have streams present than in the coastal regions of the state.

Although the variable, landowner category, was not statistically significant, small non-industrial private landowners have consistently ranked last in BMP compliance surveys. Educational efforts which concentrate on reaching forest landowners are only marginally successful due to the large number of landowners in the state. Forester and site preparation contractor education is essential in implementing a successful BMP program.



**Average slope** might generally reflect a site's relief, but **critical slope**, the extreme slope on the steeper portion of the site, may be more important in prescribing site preparation practices. A site's critical slope integrates management options into a common site characteristic expression.

The involvement of a forester in supervising site preparation operations did not improve BMP compliance, even on sites with cost-share assistance. Cost-share assistance often involves several foresters, such as a government forester, a consultant, or an industrial landowner-assistance forester. Since almost all inadequate sites were in the Piedmont, the explanation for this must be related to Piedmont conditions.

In conducting site evaluations, it became obvious that there are two ways for a forester to characterize a site's slope in making site preparation prescriptions. Slope is rarely uniform across a typical Piedmont site. Average slope might generally reflect a site's relief, but critical slope, the extreme slope on the steeper portion of the site, may be more important in prescribing site preparation practices. A site's critical slope integrates management options into a common site characteristic expression. For example, the average slope on one survey site was between 15 % and 20%, but the critical slope on this site was 64%. A prescription made for this site based on average slope may not be appropriate for the steeper sections. This is especially important when the critical slope approaches 20%, where intensive mechanical methods are not recommended.



# SUMMARY and

In this initial baseline survey, compliance with silvicultural BMPs was 86.4% on site-prepared land in South Carolina. Four major site preparation treatments were investigated: mechanical treatments, herbicide application, prescribed burning, and minor drainage. BMP compliance was highest for mechanical and herbicide site preparation treatments, 92% and 88%, respectively. BMP compliance was 77% for the 13 survey sites with drainage activities. Compliance was lowest for prescribed burning with 28 of 44 sites (70%) meeting BMP guidelines.

Compliance with site preparation BMPs was not equally distributed throughout the state. BMP non-compliance was very clearly focused on the Piedmont of South Carolina where compliance was 64.5%. Only two sites in other physiographic regions of the state received inadequate ratings. In the Piedmont, mechanical, herbicide, and prescribed burning treatments all contributed to likely off-site water quality problems. In particular, BMP compliance was significantly lower on Piedmont sites with streams present and where slopes exceeded 11%.

Drainage activities were fairly uncommon on survey sites, occurring on only 13 of the 177 sites (7.3%). Drainage was used primarily on flatwood sites to remove excess surface water in order to minimize harvesting impacts or to facilitate regeneration of desired wetland species. However, ditching did not comply with BMPs on three sites, where the hydrology appeared to be significantly altered. Ditching on these three sites likely would not qualify for the silvicultural exemption under Section 404 of the Clean Water Act.

An interesting finding of this survey is that compliance with BMPs did not significantly differ whether or not a forester was involved in the prescription and supervision of site preparation treatments. Even more troubling, BMP compliance was consistently lower for sites which received government cost-share funds to assist non-industrial private landowners with reforestation expenses. The responsibility for advising non-industrial pri-

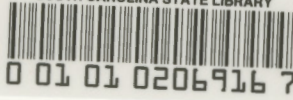


# CONCLUSIONS

vate landowners of their reforestation alternatives is typically the joint responsibility of government foresters, private consultants, and industrial landowner-assistance foresters. Foresters appeared to prescribe site preparation treatments based on a site's average slope rather than the critical slope, that is, the extreme slope on the steeper portions of a site.

BMPs have existed in South Carolina since the late 1970s, however, it wasn't until the early 1990s that BMP programs began receiving more emphasis. Outdated BMP manuals were revised and BMP training programs for foresters, landowners, and loggers were offered. As a result, three BMP compliance surveys in South Carolina documented an increase in compliance for harvesting BMPs from 84% in 1991 to 90% in 1994. However, harvesting and road construction activities received the initial focus with site preparation receiving little attention. With increased educational efforts for foresters and site preparation contractors, similar increases in compliance should be possible for site preparation activities.





# RECOMMENDATIONS

Based upon the results of this study, compliance with silvicultural site preparation BMPs can be improved by redirecting the nonpoint source pollution program to emphasize the following points.

- ◆ Existing BMP educational programs should be expanded to focus on site preparation. Foresters and site preparation contractors should be the targeted audience.
- ◆ Site preparation BMP programs should emphasize the identification and protection of sensitive sites. In the Piedmont, BMP educational programs should emphasize the role of slope as a tool in making site preparation prescriptions. On the coast, BMP programs should emphasize wetland issues, such as minor drainage and hardwood-to-pine conversion issues.
- ◆ BMP programs should become more proactive, utilizing specially-trained BMP foresters who can offer courtesy BMP exams on sensitive sites to landowners, foresters, loggers, and site preparation contractors. In this way, harvesting and site preparation prescriptions will be more consistently applied on sensitive sites.
- ◆ BMP monitoring of harvested sites has not been updated since the publication of South Carolina's Best Management Practices for Forestry in 1994. A fourth round of BMP monitoring for harvested sites should be initiated statewide to determine the level of compliance with South Carolina's new BMP guidelines.
- ◆ Site preparation monitoring should be incorporated into a routine BMP monitoring program in order to track improvements in compliance over time.



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